Appendix D
PERFORMANCE MEASURES USED IN THE LOWER EAST COAST WATER SUPPLY PLANNING PROCESS

OVERVIEW

Performance Measures

Performance measures quantify how well or how poorly an alternative meets a specific objective. Good performance measures have the following features:

- They are quantifiable.
- They have a specific target.
- They indicate when that target has been reached.
- They measure the degree of improvement toward the target when it has not been reached.

The performance measures used in the Lower East Coast (LEC) water supply planning process are hydrological performance measures that quantify changes in hydrological conditions relative to hydrologic targets. While achieving hydrologic targets does not necessarily guarantee ecological restoration, it is assumed that recapturing the hydrological characteristics of the natural or predrained system will provide maximum opportunity for recovery of the remaining Everglades landscape patterns and hence recovery of Everglades wildlife.

The LEC water supply planning process has developed two different types of performance measures: (1) a group of performance measures developed to assess LEC water supply issues and (2) a group of environmental performance measures designed to assess the performance of natural areas. In some cases, the type of measure is specific to a particular region, while in other cases, the performance measure is common to all the regions and is referred to as a regional performance measure.

The regional category was designed to permit evaluations that are regional in scale or cross the boundaries of one or more geographic subregions. Regional performance measures also permit comparison of particular performance measures between regions. Regional performance measures developed as part of the LEC water supply planning process include review of model performance by indicator regions, hydroperiod distributions, hydroperiod matches, surface water ponding matches, and overland flow direction and magnitude.

Performance Indicators

Performance indicators, in contrast to performance measures, do not have a specific target, but are used to provide an indication of the relative behavior of each water supply alternative. For example, a stage hydrograph without a specific stage target is considered a hydrologic performance indicator. Other examples of performance indicators include water budget tables, hydroperiod distribution histograms, hydroperiod matching maps, hydroperiod improvement maps, surface water ponding maps, ground water model animations, and regional water delivery graphics.

WATER SUPPLY PERFORMANCE MEASURES

Lake Okeechobee Service Area and Lower East Coast Service Areas

Meeting 1-in-10 Year Level-of-Certainty Water Supply for 31-Year Period of Record

The 1997 water supply legislation requires the water management districts to provide, as part of the regional water supply plans, a water supply development component that includes a quantification of the water supply needs for all existing and reasonably projected future uses within the planning horizon. The level-of-certainty planning goal associated with identifying the water supply needs of the existing and future reasonable-beneficial uses shall be based upon meeting those needs for a 1-in-10 year drought event [373.0361(2)(a), F.S.]. The water management districts are charged with integrating this level-of-certainty concept into the regional water supply planning process.

One measure of whether water supply demands for the LEC Service Areas (LECSA-1, LECSA-2, and LECSA-3) can be met is if water supply restrictions can be avoided during a 31-year period of record, except during the most severe droughts. Current policy enables the South Florida Water Management District (District) to impose water restrictions during droughts to conserve water regional resources. The South Florida Water Management Model (SFWMM) mimics this policy by imposing restrictions on consumptive users when regional water supplies are diminished. Water demands are cut back due to low ground water stages in selected trigger cells (based on historical monitoring well locations) in the LEC Services Areas, low surface water stages in Lake Okeechobee, or continuation of the restriction in the dry season. The SFWMM restricts water supplies in each LEC Service Areas as needed. The Lake Okeechobee Service Area is placed on supply-side management when Lake Okeechobee levels are lower than the schedule.

Output. Results from the SFWMM are displayed as a graphic for the LEC and Lake Okeechobee service areas. The graphic displays the type of cutback (Lake Okeechobee levels, low ground water levels along the coast, or dry season criteria) and the severity and duration of cutbacks by water year (October - September). Water years are used, because counting water demand cutbacks by calendar year would double count events that extend through the dry season. An example of this output is provided in **Figure D-1**.

Target. The target is to meet a 1-in-10 year level of certainty for water supply as determined by counting the number of water years when there is a water supply cutback over the period of record. The maximum number of years with water supply cutbacks for each service area would be three years for the 31-year period of record with no events greater than seven months in duration for each service area.

Frequency of Water Restrictions for the 1965 - 1995 Simulation Period

Service Area 3 - 20BSR

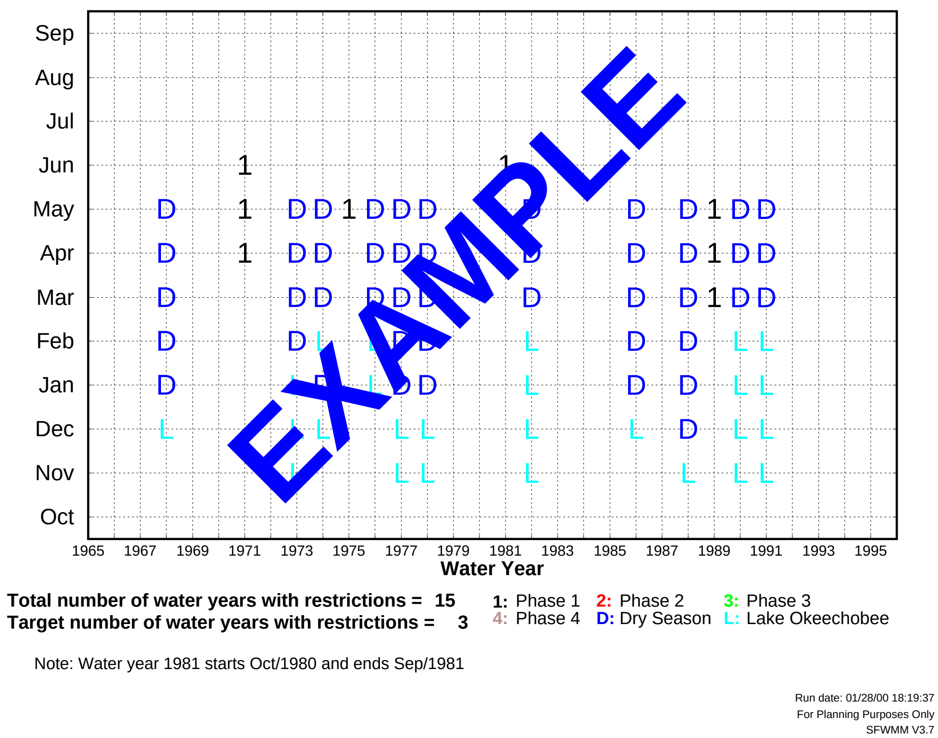


Figure D-1. An Example of the Output for the **Meeting 1-in-10 Year Level of Certainty Water Supply for the 31-Year Period of Record** Performance Measure.

Lower East Coast Service Areas

Meeting 1-in-10 Year Level-of-Certainty Water Supply for Drought Conditions

The level of certainty concept was explicitly put into state law governing water supply planning in 1997. This required a water supply development component that includes a quantification of the water supply needs for all existing and reasonably projected future uses within the planning horizon. The level-of-certainty planning goal associated with identifying the water supply needs of the existing and future reasonable-beneficial uses shall be based upon meeting those needs for a 1-in-10 year drought event (373.0361(2)(a), F.S.).

One measure of whether water supply demands for the LEC Service Areas can be met is if water supply restrictions can be avoided during a 1-in-10 year drought. Current District policy enables the District to impose water restrictions during droughts to conserve regional water resources. The ground water models mimic this policy by imposing restrictions on consumptive users when regional water supplies are diminished. Water supplies are cut back due to low ground water stages in selected trigger cells in the LEC Service Areas, low surface water stages in Lake Okeechobee, or continuation of the restriction in the dry season. Ground water stage criteria varies by location of the trigger cells and is indicated on the daily stage hydrograph for the cell. The subregional ground water models divide the LEC Service Areas into Water Restriction Areas (WRAs) to more accurately reflect how the District's water shortage policy may be implemented.

Outputs. Results from the ground water models are displayed spatially for each service area (**Figure D-2**) and as a table showing the location of trigger cells and the severity and duration of cutbacks by cause (Lake Okeechobee levels, low ground water levels along the coast, or dry season criteria). Information on cutbacks due to Lake Okeechobee stages is imported from the SFWMM into the subregional ground water models.

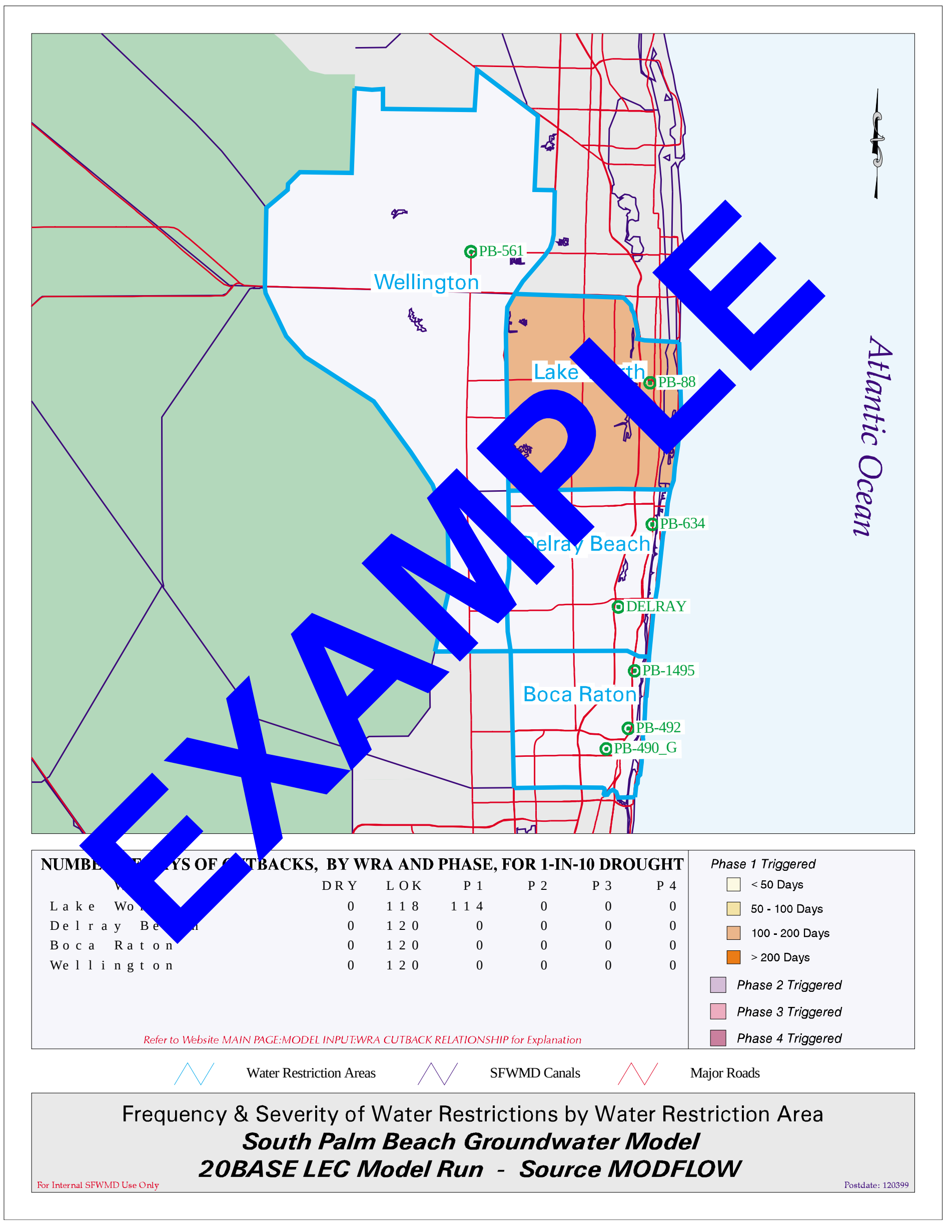


Figure D-2. An Example of the Output for the **Meeting 1-in-10 Year Level of Certainty Water Supply for Drought Conditions** Performance Measure.

Target. No water supply restrictions are incurred during a 1-in-10 year drought in the subregional ground water models due to Lake Okeechobee stages, ground water stages along the lower east coast, or due to dry season criteria.

Minimum Levels for the Biscayne Aquifer

The principal threat to maintaining the long-term functions of the Biscayne aquifer is saltwater intrusion. Saltwater intrusion is the contamination of the aquifer by salt water. The Biscayne aquifer is located along the eastern edge of Palm Beach County, underlies the majority of Broward County, and almost all of Miami-Dade County (**Figure D-3**). Along the aquifer's eastern edge, its fresh water is in contact with the salt water originating from the ocean. The constant westerly flow of fresh water from the Everglades helps to keep the salt water stationary. However, when ground water levels adjacent to the freshwater-saltwater interface are lowered, saltwater can potentially move inland replacing the fresh water (SFWMD, 1998). The higher density salt water tends to remain inland for long periods of time causing a permanent loss of that portion of the aquifer. Along the lower east coast, lowering of the ground water table due to overdrainage and increased wellfield withdrawals has allowed salt water to invade and contaminate the Biscayne aquifer during periods of drought (Parker et al., 1955). Saltwater intrusion of the Biscayne aquifer is considered one of the greatest threats to the long-term water supply of South Florida.

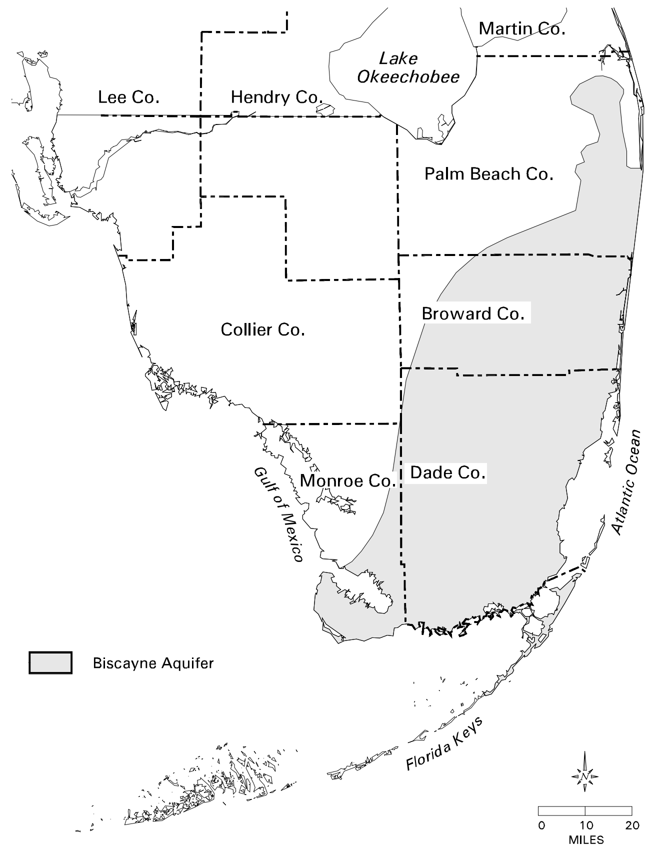


Figure D-3. Location of the Biscayne Aquifer within the LEC Water Supply Planning

Water levels in the coastal canals largely govern the expected inland migration of the saline interface. Review of water quality data from monitoring wells and modeling results show that on a regional scale, the position of the saltwater interface can be regulated by the management of water levels within the District's primary canal system. Based on this relationship, minimum water level criteria have been proposed for eleven of the District's primary canals as a means to protect a major portion of the Biscayne aquifer against saltwater intrusion (SFWMD, 1998).

Output. Model output is in the form of a table indicating the canal, water control structure, target water level, and the number of times the target was not met for 180 days in a 365-day period (**Figure D-4**).

Minimum Flow and Level Criteria for the Biscayne Aquifer

Failure to meet MFL stage criteria at control structures for 180 days or more

Canal/ Structure	MFL Stage (ft.)	Number of Times MFL Criteria Not Met 95BSR	20BSR	2020WR	LEC1	LEC1A
C-6@S-26	2.00	0	0	0	0	0
C-51@S-155	7.80	0	0	0	0	0
C-16@S-41	7.80	0	0	0	0	0
C-15@S-40	7.80	0	0	0	0	0
Hillsboro@G-56	6.75	0	0	0	0	0
C-13@S-36	4.00	0	0	0	0	0
C-14@S-37B	6.50	0	0	0	0	0
NNRiver@G-54	3.50	0	0	0	0	0
C-9@S-29	2.00	0	0	0	0	0
C-4@S-25B	2.20	0	0	0	0	0
C-2@S-22	2.20	0	0	0	0	0

Failure to meet MFL stage criteria at control structures for 90 days or more

Canal/ Structure	MFL Stage (ft.)	Number of Times MFL Criteria Not Met 95BSR	20BSR	2020WR	LEC1	LEC1A
C-6@S-26	2.00	0	0	0	0	0
C-51@S-155	7.80	0	0	0	0	0
C-16@S-41	7.80	0	0	0	0	0
C-15@S-40	7.80	0	0	0	0	0
Hillsboro@G-56	6.75	0	0	0	0	0
C-13@S-36	4.00	0	0	0	0	0
C-14@S-37B	6.50	0	0	0	0	0
NNRiver@G-54	3.50	0	0	0	0	0
C-9@S-29	2.00	4	4	0	0	0
C-4@S-25B	2.20	3	3	0	0	0
C-2@S-22	2.20	0	2	0	0	0

For Planning Purposes Only
Run date: 01/28/00 20:56:47
SFWMM V3.7
Script used: canal_mfl_lec.scr V1.2
canals_mfl_biscayne.report

Figure D-4. An Example of the Output for the **Minimum Levels for the Biscayne Aquifer** Performance Measure.

Targets. Water levels at the eleven specified water control structures (**Table D-1**) shall not fall below the proposed minimum level for more that 180 days in a 365-day period, excluding periods of flood releases. Minimum levels for the Biscayne aquifer in southeastern Miami-Dade County are not recommended at this time.

Table D-1. Recommended Minimum Canal Levels and Duration Criteria for the Biscayne Aquifer.[a]

Canal and Control Structure	Canal Stage (NGVD)[b]
C-51 Canal at S-156	7.80
C-16 Canal at S-41	7.80
C-15 Canal at S-40	7.80
Hillsboro Canal at G-56	6.75
C-14 Canal at S-37B	6.50
C-13 Canal at S-36	4.00
North New River Canal at G-54	3.50
C-9 Canal at S-29	2.00
C-6 Canal at S-26	2.00
C-4 Canal at S-25B	2.20
C-2 Canal at S-22	2.20

a. From SFWMD, 1998.

b. National Geodetic Vertical Datum; reference sea level from which elevations are measured.

WATER SUPPLY PERFORMANCE INDICATORS

Lower East Coast Service Areas

Annual Water Budget

This performance indicator graphic displays inflows and outflows for selected drainage basins in terms of average annual rainfall, evapotranspiration, ground water withdrawals, surface water flows, ground water flows, and changes in aquifer storage. Results are graphed in a bar chart for the 1-in-10 year drought period (**Figure D-5**).

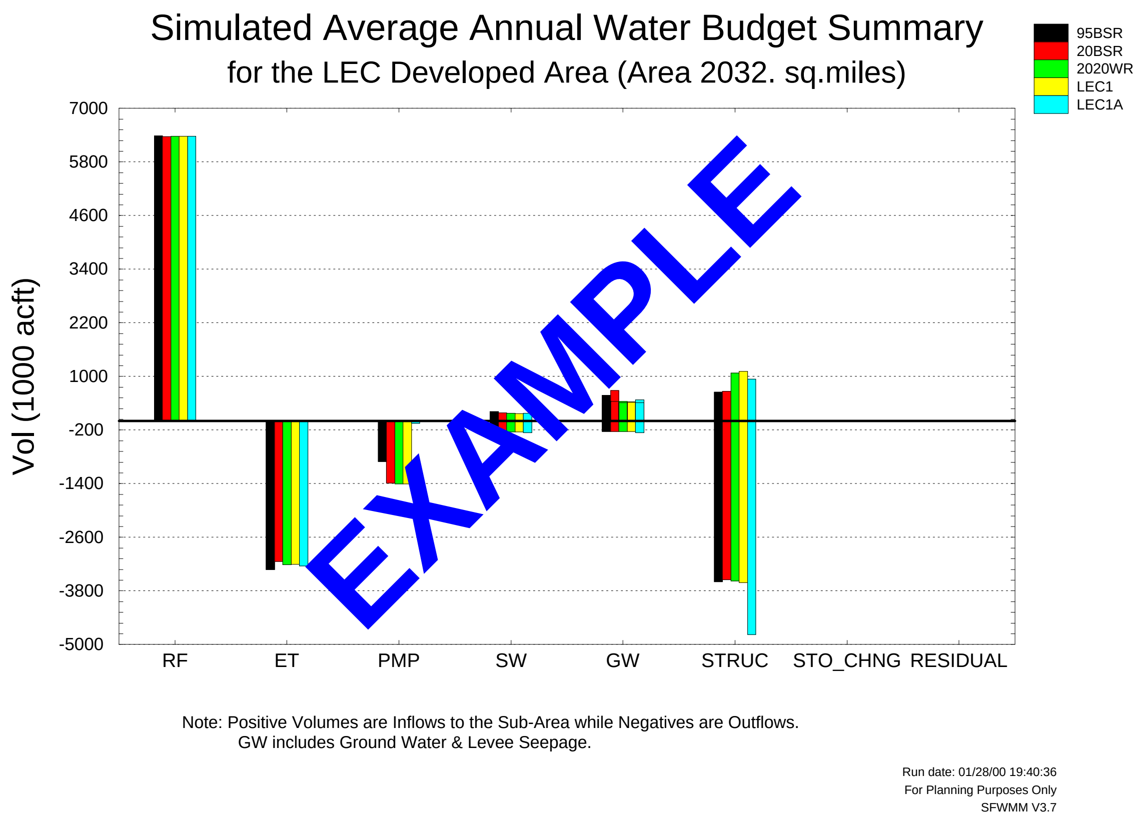


Figure D-5. An Example of the Output for the Lower East Coast Service Area **Annual Water Budget** Performance Indicator.

Daily Stage Hydrograph for Each Trigger Cell in the Water Restriction Area

The daily stage hydrograph of each trigger cell, as well as the stage criteria that triggers cutbacks for each phase, is displayed for each WRA for the two-year period of record (**Figure D-6**). If low ground water levels have the potential to threaten protection of the Biscayne aquifer, withdrawals from the aquifer are restricted in the immediate vicinity. The severity of the restriction is commensurate with the potential threat to the resource.

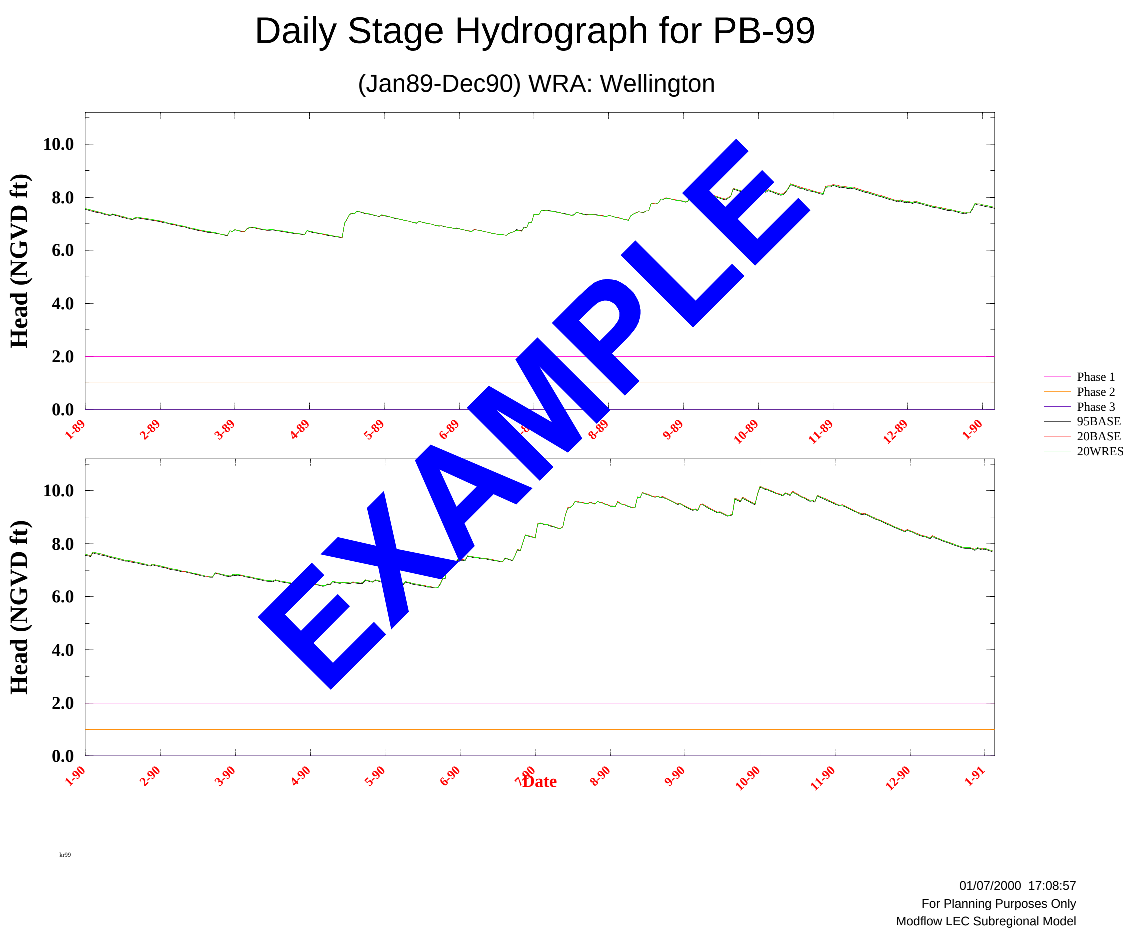


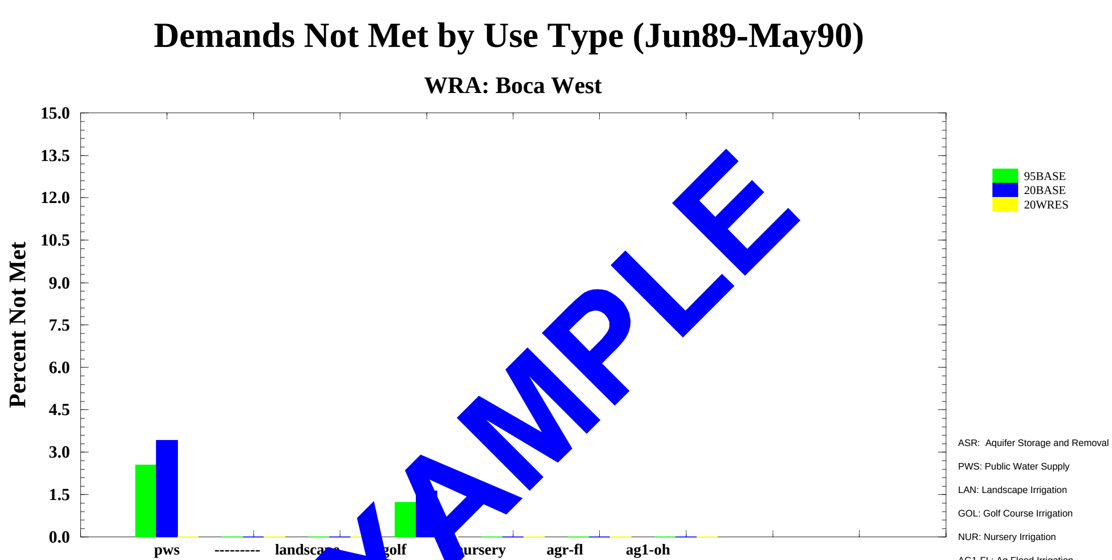
Figure D-6. An Example of the Output for the **Daily Stage Hydrograph for Each Trigger Cell in the Water Restriction Area** Performance Indicator.

Monthly Volume of Simulated Water Supply Cutbacks for Each Water Restriction Area

This performance indicator sums the monthly volume of demands not met due to water supply cutbacks as a time series for the two-year simulation period. Water supplies are cut back due to low stages in selected trigger cells in the LEC Service Areas, in Lake Okeechobee or a continuation of the restriction through the end of the dry season.

Percentage of Annual Demands and Demands Not Met, by Use Type, for Each Water Restriction Area

This performance indicator calculates the percentage of annual demands and demands not met due to water supply cutbacks by each water use type for the 1-in-10 year drought period. The percentage of annual demands met and demands not met are presented as a bar chart (**Figure D-7**). The annual volume of demands not met by water use types, including Aquifer Storage and Recovery (ASR), public water supply, agriculture overhead irrigation, agriculture flood irrigation, agriculture low volume irrigation, golf course irrigation, and nursery irrigation, are displayed in a table. Water supply cutbacks may be triggered by low stages in selected cells in the LEC Service Area or a continuation of the restriction through the end of the dry season.



Gallons of Demand Not Met for Drought Year

95BASE	72M	0	[illegible]	3M	0	0	0	0	0
20BASE	200M	[illegible]	0	4M	0	0	0	0	0
20WRES	0	0	0	0	0	0	0	0	0

Figure D-7. An Example of the Output for the **Percentage of Annual Demands and Demands Not Met, by Use Type, for Each Water Restriction Area** Performance Indicator.

Frequency and Severity of Water Supply Restrictions

Frequency and severity of water supply restriction maps display the number of days and the severity (Phase 1, Phase 2, etc.) that water supplies are restricted due to low ground water stages near the coast, low stages in Lake Okeechobee, or dry season criteria. The location of the cells experiencing low stages and the WRA affected are color coded as to the severity of the cutbacks. Each WRA is listed on a table with the duration and severity of cutbacks experienced during the 1-in-10 year drought period (**Figure D-2**).

Average Monthly Ground Water Seepage

Monthly flows across a transect or seepage collection canal associated with a WPA component are averaged for the 1-in-10 year drought period and the results are displayed in a table similar to that in **Figure D-8**. The table displays the flows as follows:

- Intercepted by the seepage/borrow canal, if applicable
- Ground water flow underneath the seepage/borrow canal, if applicable
- The seepage rate of the ponded water (water above the ground)
- The vertical cross-section area of the water ponded and the average depth of the ponded water

The first two measurements, intercept and underflow, are most applicable to reservoirs and Water Conservation Areas (WCAs) that impound water, while the last three measurements, seepage rate, cross-section area and average depth are most applicable to aboveground reservoirs. The seepage rate is only useful if water is ponded, i.e., average depth is greater than zero.

Average Monthly Groundwater Seepage
20wres

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
TOTAL	Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Underflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seepage from the Acme STA(a)	Intercept	0.09	0.08	0.09	0.06	0.07	0.16	0.34	0.42	0.39	0.31	0.13	0.09	2.22
	Underflow	0.32	0.28	0.46	0.28	0.36	0.61	1.48	1.65	1.86	1.31	0.50	0.45	9.56
Seepage from the Acme STA(b)	Intercept	-0.11	-0.11	-0.11	-0.13	[illegible]	-0.07	0.02	0.07	0.05	0.01	-0.09	-0.11	-0.72
	Underflow	-0.54	-0.54	-0.46	-0.58	[illegible]	[illegible]	0.07	0.19	0.28	-0.04	-0.45	-0.45	-3.49
Seepage from the Acme STA(c)	Intercept	0.03	0.01	0.02	0.00	[illegible]	0.02	0.07	0.10	0.11	0.10	0.05	0.04	0.55
	Underflow	0.12	0.05	0.08	0.02	0.03	0.08	0.31	0.39	0.49	0.41	0.22	0.16	2.35
TOTAL	Intercept	0.00	-0.02	[illegible]	[illegible]	[illegible]	0.11	0.44	0.59	0.55	0.41	0.09	0.02	2.05
	Underflow	-0.11	-0.21	[illegible]	[illegible]	-0.18	0.29	1.85	2.22	2.63	1.68	0.27	0.16	8.42
Seepage from the Acme Impoundment Area(a)	Intercept	0.10	[illegible]	[illegible]	0.11	0.12	0.12	0.18	0.21	0.22	0.22	0.20	0.17	1.79
	Underflow	0.35	[illegible]	[illegible]	0.51	0.58	0.51	0.73	0.87	0.94	0.96	0.85	0.72	7.60
Seepage from the Acme Impoundment Area(b)	Intercept	0.88	0.68	[illegible]	1.00	1.05	1.05	1.41	1.54	1.58	1.59	1.41	1.22	14.31
	Underflow	3.55	[illegible]	[illegible]	4.72	5.02	4.51	6.10	6.69	6.98	7.00	6.13	5.31	62.65
Seepage from the Acme Impoundment Area(c)	Intercept	1.32	[illegible]	[illegible]	1.40	1.49	1.49	1.94	2.12	2.21	2.25	2.04	1.78	20.30
	Underflow	[illegible]	[illegible]	5.52	6.55	7.19	6.45	8.44	9.23	9.75	9.96	8.92	7.80	89.16
Seepage from the Acme Impoundment Area(d)	Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Underflow	[illegible]	[illegible]	-0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.10
TOTAL	Intercept	[illegible]	1.75	2.23	2.50	2.66	2.67	3.53	3.87	4.01	4.06	3.65	3.17	36.40
	Underflow	9.26	6.91	9.79	11.77	12.79	11.47	15.27	16.78	17.66	17.90	15.89	13.82	159.31
Seepage from the PB Ag Reserve Reservoir(a)	Intercept	0.04	0.01	0.01	0.03	0.02	0.00	-0.06	-0.06	-0.05	-0.04	0.03	0.05	-0.03
	Underflow	0.25	0.11	0.06	0.12	0.11	0.01	-0.11	-0.20	-0.09	-0.03	0.08	0.12	0.42
Seepage from the PB Ag Reserve Reservoir(b)	Intercept	2.13	0.89	0.45	0.85	0.95	0.06	-1.72	-1.79	-1.08	-0.78	1.86	3.16	4.98
	Underflow	13.83	6.53	4.06	4.39	4.93	0.93	-1.88	-5.62	0.43	1.76	6.02	8.31	43.68
Seepage from the PB Ag Reserve Reservoir(c)	Intercept	0.05	0.02	0.00	-0.01	0.00	0.00	-0.01	-0.03	-0.02	0.00	0.05	0.07	0.12
	Underflow	0.37	0.15	0.09	0.00	0.01	0.00	0.07	-0.06	0.01	0.17	0.20	0.18	1.19
TOTAL	Intercept	2.22	0.92	0.45	0.87	0.97	0.05	-1.79	-1.88	-1.14	-0.81	1.94	3.28	5.08
	Underflow	14.45	6.79	4.20	4.50	5.05	0.95	-1.93	-5.88	0.36	1.90	6.29	8.61	45.29

Note: Average Monthly and Average Annual Groundwater Flow and Seepage (1000 acre-ft) for (1989-1990)
Negative values indicate flow in the reverse direction

Figure D-8. An Example of the Output for the **Average Monthly Ground Water Seepage** Performance Indicator.

Monthly Summary Report for Water Preserve Area Components

A table displays the average monthly budget for the two-year simulation of WPA components (**Figure D-9**). Budget information included for each component is as follows (some components will not include ASR facilities):

- Rainfall
- Evapotranspiration
- Seepage into the component from the bottom and sides
- Seepage out of the component through the bottom and sides
- Seepage recaptured and pumped back into the impoundment
- Seepage loss = seepage out - seepage recaptured
- ASR flows into the reservoir
- ASR flows out of the reservoir
- ASR net = ASR in - ASR out
- Reservoir outflows = evapotranspiration + surface water transferred in + seepage loss + ASR out
- Reservoir inflows = Rainfall + surface water transferred in + seepage in + ASR inflows + seepage recaptured
- Average volume = in 1,000 acre-feet/month
- Mean depth = Mean depth of the impoundment for the month
- Area = Area of the impoundment

Average Monthly LEC Component Budget:PB Ag Reserve Reservoir

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
YEAR 1989													
Rainfall	0.25	0.20	0.81	0.75	0.06	0.11	[illegible]	0.54	0.79	0.65	0.47	0.15	5.00
Evapotranspiration	0.43	0.79	0.88	0.72	0.71	0.46	[illegible]	[illegible]	0.84	0.75	0.61	0.33	7.45
Seepage Out	2.30	4.38	6.24	7.84	1.73	3.90	[illegible]	0.47	0.35	1.94	1.06	0.27	31.42
Seepage Recaptured	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seepage Loss	2.30	4.38	6.24	7.84	1.73	[illegible]	[illegible]	0.47	0.35	1.94	1.06	0.27	31.42
ASR Into Reservoir	0.00	0.00	4.56	4.98	0.00	[illegible]	[illegible]	1.42	0.00	3.18	0.00	0.00	13.98
ASR Out of Reservoir	0.00	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ASR Net	0.00	0.00	4.56	4.98	0.00	[illegible]	0.00	1.42	0.00	3.18	0.00	0.00	13.98
Reservoir Outflows	2.73	5.17	6.93	8.56	3.18	[illegible]	1.44	1.13	1.19	2.68	2.01	0.60	39.96
Reservoir Inflows	4.94	6.78	5.38	6.38	[illegible]	[illegible]	0.13	1.95	0.79	3.74	0.47	0.15	40.07
YEAR 1990													
Rainfall	0.11	0.81	0.14	0.11	[illegible]	0.79	0.19	0.15	0.27	0.86	0.55	0.26	4.47
Evapotranspiration	0.58	0.66	0.78	[illegible]	[illegible]	0.84	0.71	0.33	0.66	0.74	0.58	0.44	7.32
Seepage Out	3.06	6.24	4.97	[illegible]	0.56	0.35	1.96	0.27	0.00	2.11	3.13	4.04	30.59
Seepage Recaptured	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seepage Loss	3.06	6.24	[illegible]	[illegible]	0.56	0.35	1.96	0.27	0.00	2.11	3.13	4.04	30.59
ASR Into Reservoir	0.04	4.56	[illegible]	[illegible]	0.00	0.00	1.32	0.00	0.00	0.93	0.59	0.00	7.44
ASR Out of Reservoir	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ASR Net	0.04	4.56	0.00	0.00	0.00	0.00	1.32	0.00	0.00	0.93	0.59	0.00	7.44
Reservoir Outflows	3.64	6.90	10.68	4.35	1.18	1.19	2.67	0.60	0.67	2.85	3.89	4.48	43.11
Reservoir Inflows	5.96	5.38	3.34	2.98	0.22	0.79	3.22	0.15	0.42	3.64	1.61	6.52	34.14

Note: Average Monthly and Average Annual Water Budgets in 999 acre-ft for (1989-1990)

EXAMPLE

Figure D-9. An Example of the Output for the **Monthly Summary Report for Water Preserve Area Components** Performance Indicator.

Lower East Coast Wetland Drawdown Criteria

One of the concerns with withdrawals from the Biscayne aquifer and surface waters is the potential to impact wetlands. By comparing runs with and without public water supply, irrigation, and agricultural withdrawals, the effect of these consumptive uses can be evaluated. When the difference in heads within a wetland is one foot or greater for 30 days, it is tallied and displayed on a map of the model area (**Figure D-10**). This performance indicator is similar to the consumptive use criteria for permits. This performance indicator is only applied to the subregional ground water models in the LEC Service Areas.

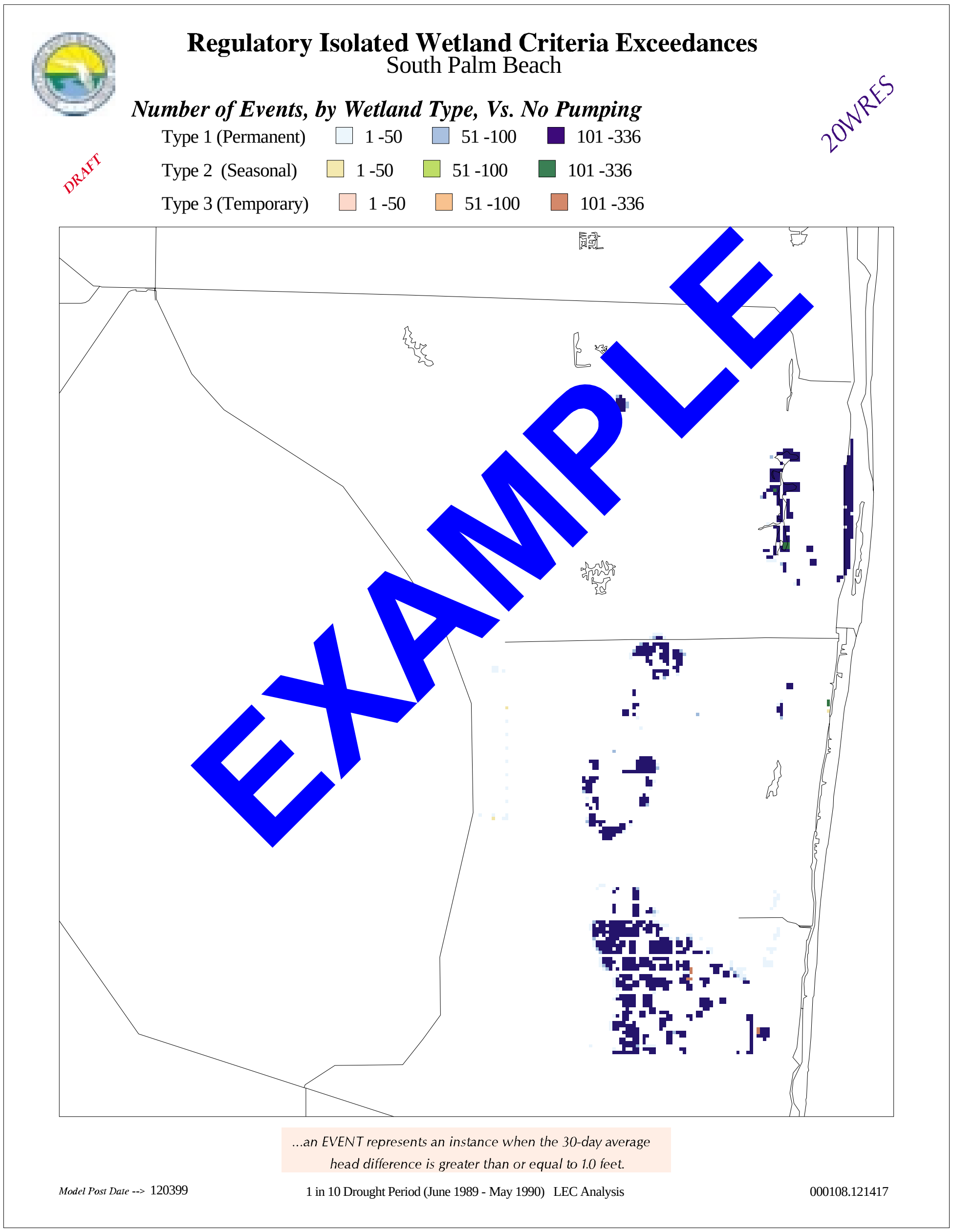


Figure D-10. An Example of the Output for the **Lower East Coast Wetland Drawdown Criteria** Performance Indicator.

Magnitude of Net Westward Flow Along the Coast

Another concern is whether withdrawals may affect the saltwater interface. If the ground water flow east towards the coast is less than the flow west towards a wellfield, the saline interface has the potential to move. By measuring ground water flows east and comparing them to westward flows, the net westward flow can be calculated and presented on a map (**Figure D-11**). Only when the net flow to the west is greater is the magnitude of the flow indicated. The net flow is calculated for both the water table, and the production zone. This performance indicator is only applied to the subregional ground water models in the LEC Service Areas.

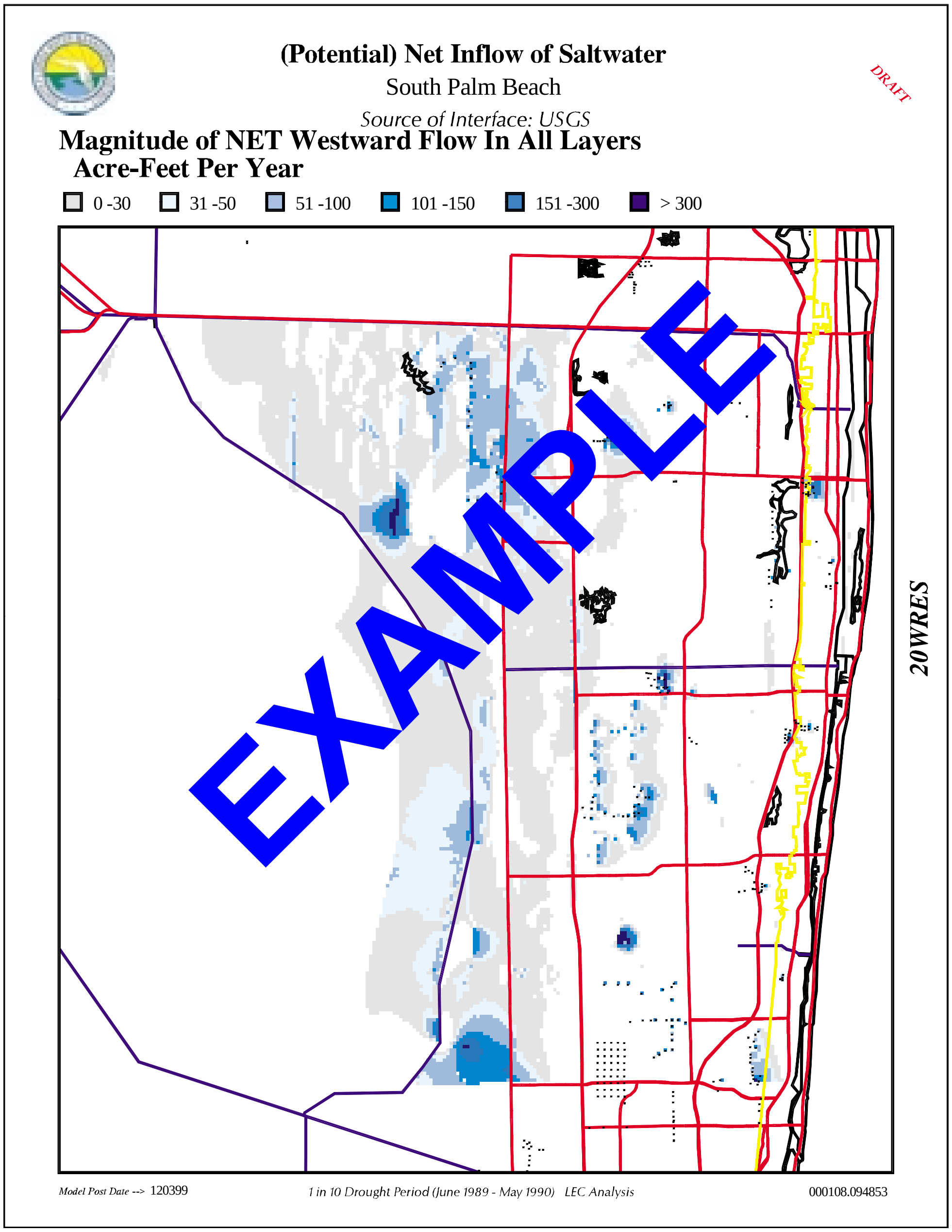


Figure D-11. An Example of the Output for the **Magnitude of Net Westward Flow Along the Coast** Performance Indicator.

ENVIRONMENTAL PERFORMANCE MEASURES FOR NATURAL AREAS

Lake Okeechobee

Minimum Water Level Criteria

A critical performance measure used to evaluate the various LEC water supply alternatives is the ability to meet Minimum Flows And Levels (MFL) criteria proposed for Lake Okeechobee (SFWMD, 1998). Minimum water level criteria for the lake consist of two components: 1) day-to-day operational MFL criteria used to identify when the MFL has been exceeded on a day-to-day basis and 2) longer-term water supply planning MFL criteria to determine how often, and for what duration, the MFL may be exceeded based on the expected frequency of natural drought conditions.

Target. In this evaluation we used the water supply planning MFL criteria to measure the performance of each water supply alternative. These criteria are defined as follows:

Water levels in the lake should not fall below 11 ft NGVD for more than 80 days duration, more often than once every six years on average.

Lake Okeechobee Priority Performance Measures

Five priority performance measures were developed for Lake Okeechobee as part of a draft conceptual model (Havens and Rosen, 1999). These five hydrologic variables are thought to play a major role in controlling ecosystem structure and function within the lake. The number of extreme high and extreme low water events (water level fluctuation) and timing of lake stages have a major effect on the distribution of native and exotic plant communities, and in turn impact habitat quality (vegetation cover, nesting sites, foraging habitat) available for fish, birds, and other aquatic dependent wildlife. Five performance measures were developed to evaluate the frequency, duration, and severity of extreme water events in Lake Okeechobee:

- Number of extreme high lake stage events (above 17 ft NGVD) which impact the ecosystem and increase the risk of flood control
- Number of prolonged, moderately high lake stages (above 15 ft NGVD for longer than 1 year)
- Number of prolonged, moderately low lake stages (below 12 ft NGVD for more than 1 year)
- Number of extreme low water events (below 11 ft NGVD) which completely dry out the littoral zone
- Number of spring water level recession events; the number of times water levels decline from near 15 ft to 12 ft NGVD during the months

of January through March, without a water level reversal greater than 0.5 feet, over the 31-year simulation period

Target. Water supply alternatives that best meet the five priority performance measures and MFL criteria listed above will be judged as best for protecting Lake Okeechobee.

Caloosahatchee Estuary

Performance Measures

The following performance measures and estuary protection targets were developed for the Caloosahatchee Estuary based on the work of Chamberlain and Doering (1997). These performance measures focus primarily on reducing the number of high discharge events that impact the estuary due to releases from Lake Okeechobee and local drainage basins. Low flow limits are also proposed. MFL criteria have not yet been developed for the Caloosahatchee Estuary. The performance measures are as follows:

- High Discharge Criteria - The number of times that mean monthly flows exceed 4,500 cubic feet per second (cfs). Mean monthly flows above 4,500 cfs results in freshwater conditions throughout the entire estuary.
- Estuary Protection Criteria - The number of times that mean monthly flows exceed 2,800 cfs. Mean monthly flows in excess of 2,800 cfs contribute to poor water quality conditions such as unfavorable salinity and increased turbidity and color which impact estuarine biota.
- Low Flow Criteria - The number of minimum flows of 300 cfs were not met within the estuary. Insufficient freshwater inflows cause hypersaline conditions, impacting estuarine seagrasses, fish and invertebrates, including critical indicator species (e.g. *Vallisneria).*

Targets. Based on a flow optimization study of the estuary (Chamberlain and Doering, 1997), the following flow targets have been established for the Caloosahatchee River Estuary (**Table D-2**):

- High Discharge Target - No more than six events with mean monthly flows exceeding 4,500 cfs
- Estuary Protection Target - No more than 22 events with mean monthly flows exceeding 2,800 cfs
- Low Flow Limit - No more than 60 months with mean monthly flows less than 300 cfs

Table D-2. Flow Targets for the Caloosahatchee Estuary.

Target	Mean Monthly Flow Range	Maximum Number of Events or Months Duration
High Discharge	> 4500 cfs	6 Events
Estuary Protection	> 2,800 cfs	22 Events
Low Flow	< 300 cfs	60 Months

St. Lucie Estuary

The following performance measures and estuary protection targets were developed for the St. Lucie Estuary as part of the Central and Southern Florida Project Comprehensive Review Study (Restudy) (USACE and SFWMD, 1999). As part of the LEC planning process, these targets and performance measures have been updated and modified based on the most recent information. The variables and performance measures have targets based on optimum flows and hydrologic conditions that would support habitat for fish, wildlife, and other aquatic resources. Again, these performance measures focus on reducing the number of high discharge events that impact the estuary due to releases from Lake Okeechobee and local drainage basins and meeting the proposed flow targets. Low flow limits are also proposed. MFL criteria have not yet been developed for the St. Lucie estuary. The performance measures are as follows:

- High Discharge Criteria - The number of times that mean monthly flows exceed 3,000 cfs. Mean monthly flows above 3,000 cfs result in freshwater conditions throughout the entire estuary.
- Estuary Protection Criteria - The number of times that mean monthly flows exceed 2,000 cfs. Mean monthly flows in excess of 2,000 cfs contribute to poor water quality conditions such as unfavorable salinity and increased turbidity and color which impact estuarine biota.
- Low Flow Criteria - The number of months minimum flows of 350 cfs were not met within the estuary. Insufficient freshwater inflows cause hypersaline conditions, impacting estuarine seagrasses, fish, and invertebrates.

Targets. Based on a flow optimization model of the estuary (Otero et al., 1995), the following flow targets have been established for the St. Lucie Estuary (**Table D-3**):

- High Discharge Target - No more than five events are allowed over the 31-year simulation period with mean monthly flows exceeding 3,000 cfs.
- Estuary Protection Target - No more than 23 events are allowed over the 31-year simulation period with mean monthly flows exceeding 2,000 cfs.

- Low Flow Limit - No more than 178 months with mean monthly flows less than 300 cfs are allowed over the 31-year simulation period.

Table D-3. Flow Targets for the St. Lucie Estuary.

Target	Mean Monthly Flow Range	Maximum Number of Events or Months Duration	Return Frequency not to be Exceeded
High Discharge	> 3000 cfs	5 Events	1-in-74
Estuary Protection	> 2000 cfs	23 Events	1-in-16
Low Flow	< 350 cfs	178 Months[a]	1-in-2

a. Over the 31-year simulation period.

Lake Worth Lagoon

The Lake Worth Lagoon currently experiences large volumes of poor quality water released to the estuary from the C–51 Canal. These releases cause large fluctuations in salinity, poor water quality, and increased sedimentation and turbidity near inflow structures (S-155, S-40, and S-141). Two performance measures for the Lake Worth Lagoon have been proposed:

- Number of times the 14-day moving average exceeds 500 cfs over the 31-year simulation period (modeling results have indicated that 500 cfs creates a steady state salinity of about 23 parts per thousand (ppt) within the lagoon).
- Mean wet and dry season flows delivered to Lake Worth via S-40, S-41, and S-155 for the 31-year simulation period

Target. Peer reviewed science–based hydrologic targets have not yet been determined for the Lake Worth Lagoon. The interim goal is to reduce, as much as possible, the number of high discharge events that impact the estuary. The maximum flow target is based on previous hydrodynamic modeling of the lagoon where 500 cfs produced a steady-state salinity of approximately 23 ppt. Until better information becomes available, this will be the interim high flow target for the lagoon. Model results are displayed in a bar graph format for the base cases and each proposed water supply alternative as shown in **Appendix H**.

Everglades

Performance measures for the Everglades were created with the intent of restoring the essential hydrologic features of the natural system that once existed prior to drainage and development of the region. The majority of performance measures developed for the Everglades were based on restoring the hydrologic patterns predicted by the Natural

System Model version 4.5F (NSM v4.5F). As part of the LEC water supply planning process the Scientific Working Group (1994) concluded that the NSM "…represents a reasonable estimate of hydrologic patterns as restoration targets for the Holey Land and Rotenberger Wildlife Management Areas (WMAs), Water Conservation Areas 1, 2, and 3, Everglades National Park, and the Big Cypress Preserve…." In addition, the NSM also appears consist with what is known or hypothesized about the optimum hydrologic patterns that will support the characteristic soils, plant and animal communities commonly associated with the Everglades Basin (Fennema et al., 1994). Performance measures utilized in this study were developed to evaluate each water supply plan's potential for the following:

- Protection and accretion of peat and marl soils as indicated by a low predicted occurrence of extreme low water events
- Protection of tree island communities as indicated by a low predicted frequency of extreme high water events
- Reestablishment of surface water inundation patterns that will maintain Everglades sawgrass or ridge and slough marsh communities as indicated by the number and duration of inundation events that closely match NSM-defined targets for a particular indicator region (see next section)

The LEC evaluation team also recognized that the NSM might not necessarily be the appropriate target for some areas of the Everglades. For example, the NSM is a relatively poor predictor of natural system conditions near model boundaries or where topographic features are not well known or represented in the model. In some areas, NSM predictions may conflict with what is currently known about the biology of a particular plant or animal community. In these instances the LEC Evaluation Team utilized the modified targets proposed in the Restudy for the following areas:

- The Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1) targets were the 1995 Base, in keeping with the current regulation schedule for the area.
- Indicator Region (IR) 17 (in south central WCA-3A) performance values were compared against the average NSM values for IR 14 and IR 18. This target value was selected because the NSM values for IR 17 were identified as being too low for this rather pristine area. For indicator regions in WCA-3B, not only NSM is considered, but also the number of high water events should be minimized.
- For high water extremes, the performance measure was that number and duration of events less than or equal to NSM.
- For low water extremes, the performance measure target was for frequencies and duration of events to be minimized.

Indicator Regions

Model results for each alternative were evaluated at the level of individual indicator regions. An indicator region is a grouping of model grid cells within the SFWMM that consists of similar vegetation cover and soil type. These larger groupings of cells were developed to reduce the uncertainty of evaluating results from a single two by two square mile grid cell that represents a single water management gauge or area. **Figure D-12** provides the location of each indicator region evaluated in this study. For

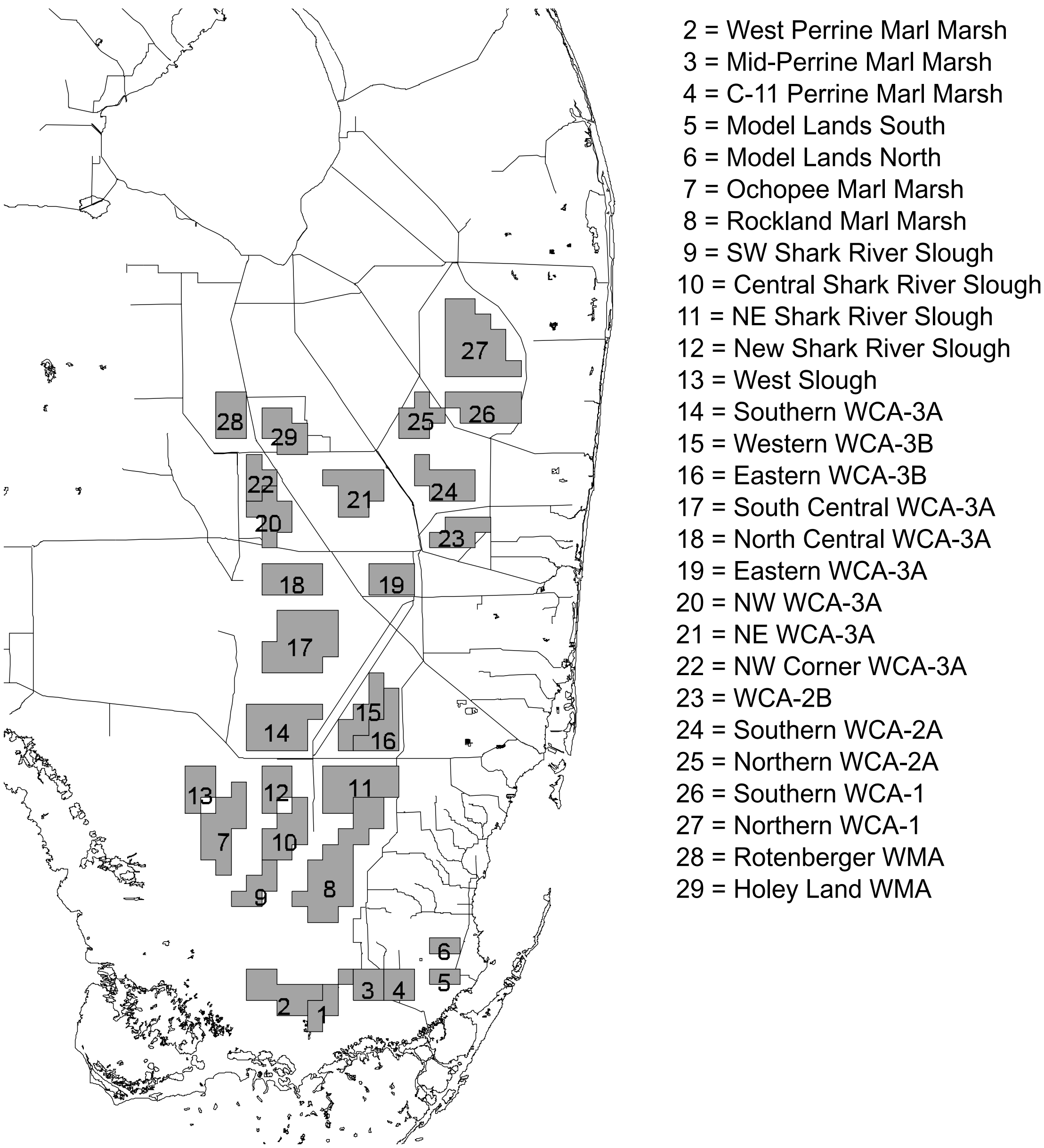


Figure D-12. Locations of Indicator Regions Within the Everglades Evaluated by the SFWMM for the Lower East Coast Regional Water Supply Plan.

final analysis, indicator regions that fell within areas of similar hydrological conditions or within the same impoundment system were grouped together. The final evaluation classified the indicator regions into 14 hydrological subregions of the Everglades:

- Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1): IR 26 and IR 27
- Holey Land and Rotenberger WMAs: IR 28 and IR 29
- WCA-2A: IR 25 and IR 24
- WCA-2B: IR 23
- Northeast WCA-3A: IR 21
- Northwest WCA-3A: IR 20 and IR 22
- East-Central WCA-3A: IR 19
- Central and Southern WCA-3A: IR 14, IR 17, and IR 18
- WCA-3B: IR 15 and IR 16
- Northeast Shark River Slough: IR 11
- Central Shark River Slough: IR 9 and IR 10
- Northwest Shark River Slough: IR 12
- Rockland marl marsh: IR 8
- Taylor Slough: IR 1

Each of the above indicator regions were evaluated using the following set of priority performance measures:

- The ability to meet Everglades MFL criteria (SFWMD, 1998)
- The ability to meet NSM-defined patterns of surface water flooding inundation/duration
- Number and duration of extreme high and low water events
- Interannual depth variation (average and standard deviation of water depths for the months of May and October for the 31-year simulation period)
- Temporal variation in mean weekly stage

Minimum Flows and Levels

Establishment of MFLs is a statutory requirement (Chapter 373.042(1), F.S.) that mandates all water management districts to establish MFLs for priority surface waters and aquifers within their jurisdiction. In July 1998, a draft technical document was developed identifying proposed minimum water level depths, duration, and frequencies of occurrence for Lake Okeechobee, the Everglades, and the Biscayne aquifer (SFWMD, 1998). The following minimum water level criteria were derived from this draft document. Two criteria are proposed for wetlands overlying peat-forming and marl-forming soils.

Targets. Targets for the Everglades MFL performance measure are as follows:

- MFL criteria for peat-forming wetlands: Water levels within wetlands overlying organic peat-forming soils within the WCAs, the Rotenberger and Holey Land WMAs, and Shark River Slough should not fall 1.0 foot or more below ground level for more than a 30-day duration, at return frequencies that are not less than those shown in **Table D-4**.
- MFL criteria for marl-forming wetlands: Water levels within marl-forming wetlands that are located in the area east and west of Shark River Slough, the Rocky Glades, Taylor Slough, and the C-111 Basin should not fall below 1.5 feet below ground level for more than 90 days, at a return frequency of not more than once in five years (SFWMD, 1998) (**Table D-4**).

Table D-4. Minimum Water Levels, Duration, and Return Frequencies for Selected Key Water Management Gauges Located Within the Everglades.

Area	Key Gauge	IR	Soil Type	Minimum Depth (ft) and Duration (days)	Return Frequency (years)[a]
Loxahatchee National Wildlife Refuge (WCA-1)	1-7	27	Peat	-1.0 ft >30 days	1-in-4
WCA-2A	2A-17	24	Peat	-1.0 ft >30 days	1-in-4
WCA-2B	2B-21	23	Peat	-1.0 ft >30 days	1-in-6
Holey Land WMA	HoleyG	29	Peat	-1.0 ft >30 days	1-in-3
Rotenberger WMA	Rotts	28	Peat	-1.0 ft >30 days	1-in-2
Northwest corner of WCA-3A	3A-NW	22	Peat	-1.0 ft >30 days	1-in-4
Northwestern WCA-3A	3A-2	20	Peat	-1.0 ft >30 days	1-in-4
Northeastern corner of WCA-3A	3A-3	68	Peat	-1.0 ft >30 days	1-in-3
Northeastern WCA-3A	3A-NE	21	Peat	-1.0 ft >30 days	1-in-2
Central WCA-3A	3A-4	17	Peat	-1.0 ft >30 days	1-in-4
Southern WCA-3A	3A-28	14	Peat	-1.0 ft >30 days	1-in-4
WCA-3B	3B-SE	16	Peat	-1.0 ft >30 days	1-in-7
Northeastern Shark River Slough	NESRS-2	11	Peat	-1.0 ft >30 days	1-in-10
Central Shark River Slough	NP-33	10	Peat	-1.0 ft >30 days	1-in-10
Southwestern Shark River Slough	NP 36	9	Peat	-1.0 ft >30 days	1-in-7
Marl wetlands east of Shark River Slough	NP-38	70	Marl	-1.5 ft >90 days	1-in-5
Marl wetlands west of Shark River Slough	NP-201/G-620	12	Marl	-1.5 ft >90 days	1-in-5
Rockland Marl Marsh	G-1502	8	Marl	-1.5 ft >90 days	1-in-5
Taylor Slough	NP-67	1	Marl	-1.5 ft >90 days	1-in-5

a. Return frequencies for peat-forming wetlands were based largely on output of NSM v4.5, while those for marl-forming wetlands were based on recommendations by Everglades National Park scientists.

Inundation/Duration Patterns

Reestablishment of annual and interannual patterns of surface water inundation and drying is a key performance measure for restoration of the Everglades system. For each indicator region this performance measure calculates the number of continuous ponding events over the 31-year simulation period, the average duration of these ponding events in terms of week/event, and the average annual hydroperiod in terms of percent of time inundated over the 31-year simulation period. An example of this performance measure is shown in **Appendix H**.

Target. For most areas of the Everglades system the target is the inundation/ duration patterns characterized by the NSM unless otherwise noted. These results are displayed for the NSM, base cases, and each proposed water supply alternative in the Inundation Duration Summary for indicator regions table in **Appendix H**.

Duration of Uninterrupted Surface Flooding

This performance measure was utilized primarily for evaluation of model output for Everglades National Park. Although similar to the inundation/duration performance measure, this performance measure compares patterns of uninterrupted surface water flooding at Everglades National Park indicator regions by calculating the number of times and duration an indicator region was continuously flooded 0.2 feet above ground level over the 31-year simulation period. Field observations indicate that when water depths drop to less than 0.2 feet during a flood event, aquatic fauna population densities decline, survivors retreat to refugia in solution or alligator holes, and population recovery is slowed (Loftus and Eklund, 1994; USACE and SFWMD, 1999)).

Target. Water supply alternatives, which best match NSM patterns of uninterrupted flooding, were judged as best for recovery of the ecosystem. These results are displayed for the NSM, base cases, and each proposed water supply alternative as shown in the Duration of Uninterrupted Flooding for indicator regions table in **Appendix H**.

Extreme High and Low Water Events

These two performance measures were developed to evaluate the performance of water supply plans for causing peat loss resulting from an increase in the frequency of extreme low water events and protection of tree island communities that may be impacted by extreme high water conditions. The extremely low water performance measure assesses the frequency and duration that water levels exceed values associated with damage to peat-forming regions of the Everglades. Damages include muck fires and microbial oxidation of peat (soil subsidence) caused by extreme low water events. In contrast, the high water performance measure calculates the number and duration of extreme high water events that potentially could impact tree island communities and Everglades wildlife. The number of times the high and low water criteria values are exceeded are obtained for each cell, and then averaged for all the cells within the indicator region to obtain the number of extreme events and average duration for the 31-year simulation period.

Target. Water supply alternatives which best match NSM patterns of extreme high and low water were judged as best for recovery of the ecosystem. Model results are displayed for the NSM, base cases, and each proposed water supply alternative in the High Water Summary and Low Water Summary tables in **Appendix H**. These tables show the extreme high and low water depth criterion, the number of extreme events, their average duration (in weeks), and the average annual duration over the 31-year simulation period.

Interannual Depth Variation and Temporal Variation in Mean Weekly Stage

Water management has changed the temporal pattern of variation in water depth throughout the peat-forming and marl-forming soil landscapes of the Everglades. This includes changes in the timing of annual high and low water, the amplitude of depth variation, and the degree of year-to-year variation in water depth. Such alterations in the timing and delivery of water to the marsh are believed to cause significant effects on seasonally dependent events in the lives of Everglades organisms. The interannual depth variation and temporal variation in mean weekly stage performance measures were developed to provide for sustainable populations of native plants and animal species, restoration of more natural hydropatterns, and restored distribution of surface freshwater flows throughout the remaining Everglades, in response to rainfall and antecedent hydrological conditions. The interannual depth variation and temporal variation in mean weekly stage are two measures used to compare predicted hydropattern conditions with target values that support these objectives. The performance measures were applied to the northern and central Everglades, including the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1), Holey Land and Rotenberger WMAs, WCA-2, and WCA-3.

Interannual depth variation is used to evaluate seasonal and annual variability of the marsh hydroperiod. Water depth for the months of May and October are averaged over the grid cells within a specific indicator region. The mean and standard deviation is calculated for the indicator region over the 31-year period used in the SFWMM model simulation. These values are presented in a tabular format for each alternative and indicator region.

Temporal variation in mean weekly stage is a calculation of the average water depths for a given week over the 31-year simulation period. The mean depths for each week were averaged over the grid cells within a specific indicator region. The between-year standard deviation in weekly mean depth was also calculated and these values are displayed in a graphical format.

Targets. Water supply alternatives which best reflect NSM-defined targets for these two performance measures will be judged as better for improving temporal patterns of variation in water depth throughout the peat-forming and marl-forming soil landscapes.

Biscayne Bay

Since the early 1900's, the hydrology of Biscayne Bay has been extensively modified due to coastal construction and the development of the extensive water management system now in place (Wanless et al., 1984). Freshwater flows to the bay have been highly modified from predevelopment patterns, limiting surface and ground water flows to the bay. Currently the main sources of flow to the bay are local rainfall and canal discharges. During the wet season, large volumes of fresh water are discharged to the bay via the flood control structures causing wide variations in salinity near canal inflow points and reduced salinity on the western fringe of the bay (Wang et al., 1978). Increased surface water runoff during the rainy season has also impacted inflow water quality by increased nutrient loading, sedimentation, and turbidity (Alleman et al., 1995).

Performance Measures

Performance measures are based on the mean annual wet and dry season flows discharged into five regions of the bay through the following water management structures:

- Snake Creek (S-29)
- North Bay (G-58, S-28, S-27)
- Miami River (S-25, S-25B, S-26)
- Central Bay (G-97, S-22, S-123)
- South Bay (S-21, S-21A, S-20F, and S-206).

These performance measures were developed as part of the Restudy (USACE and SFWMD, 1999) and are intended to provide a surface water inflow regime that will support salinity conditions that will not cause further damage to the ecosystem.

Target. The target applied to these regions is the current mean annual flow discharged to Biscayne Bay under the 1995 Base Case, with a 30 percent increase in flow applied to dry season discharges for the central and south bays. For Snake Creek (S-29), a separate target was developed based on canal discharge that maintains salinity ranges suitable for oyster survival. These results are displayed in a bar graph format base cases and each proposed water supply alternative as shown in **Appendix H**.

REGIONAL PERFORMANCE INDICATORS

As discussed previously, performance indicators do not have specific targets, but are used to provide an indication of the relative behavior of each water supply alternative. The following performance indicators were used in the evaluation of each proposed water supply alternative reviewed in this plan.

Weekly Stage Hydrographs

Stage hydrographs represent the time series of a water stage at a particular location. The location is typically the value of a grid cell, either 500 feet by 500 feet or two miles by two miles, depending on the model. Stage hydrographs can be used to compare hydrograph characteristics with those of different alternatives at the specific location, providing information on how well each alternative performs with regard to the duration and severity of seasonal water level fluctuations, minimum and maximum levels, the occurrence and frequency of dry out, or the duration and severity of water restrictions. Hydrographs are located throughout the model area in wetlands, near Water Preserve Areas (WPA) components, wellfields, and along the coast.

Stage Duration Curves

Stage duration curves provide an indication of the cumulative probability that a particular stage is exceeded or not exceeded. Stage duration curves are produced at the same locations as the stage hydrographs. From the duration curve the probability of exceeding a given stage is easily quantified for each alternative. It is useful to understand how the area performs during the high and low water extremes.

Normalized Stage Hydrographs and Duration Curves

Normalized stage hydrographs and normalized stage duration curves are used to reference stages with respect to land elevation rather than NGVD to facilitate comparison of ponding depths. When applying the SFWMM, this is important in comparing stages from different alternatives with the NSM values where land subsidence has occurred. For the subregional ground water models, normalization facilitates understanding the ponding frequency and duration of wetland systems, while comparing ground water heads measured relative to NGVD is useful for understanding water levels near the saltwater interface or wellfields.

Hydroperiod Distributions and Hydroperiod Matches

Hydroperiod distribution maps of the model area and histograms indicate the total area inundated for 30-day inundation period classes for each of the alternatives compared. For the subregional models, a hydroperiod distribution map for each model displays the spatial distribution of the average hydroperiod. In addition, a histogram is generated for each natural area of interest summing the acreage in each hydroperiod class. Both the map and the histogram are divided into 30-day inundation period classes.

For the SFWMM, cell-by-cell maps and histograms of the hydroperiod distribution were developed to determine how well predrainage spatial inundation patterns are reproduced by each alternative. Cell-by-cell comparisons determine how alternatives compare to, or match, the predrainage system as simulated with NSM at each modeled grid cell and indicate where changes have taken place. Hydroperiod histograms measure conditions over an area or for a particular landscape.

Histograms quantify the area that matches the inundation pattern simulated by the NSM for each alternative and provide a quick overview of the regional performance. Inundation patterns within plus or minus 30 days of those of the target are considered to match NSM. Histogram classes quantify the areas that have either longer or shorter inundation periods than NSM. This is applied only to those areas where NSM is the target.

Ground Water Flows, Heads, and Overland Flows

The subregional ground water models segregate the surficial aquifer system into multiple layers. The top layer simulates wetlands and soil transmissivity. Simulations of the top layer (Layer 1) enable the reviewer to understand how wetlands and other natural features perform. The production zone (Layer 2 or 3, depending on the model) generally simulates the most productive area of the aquifer. Review of the ground water heads in this layer provides insights of the effects of ground water withdrawals.

To understand how water flows across large spatial areas, animations of the direction and the magnitude of volume of water flows are displayed. For each model area, the change in the direction and volume of ground water flows over time can be viewed. These changes provide a general understanding or an overview of how flows are affected. For the subregional models, ground water flows are simulated for the water table (generally Layer 1), while the SFWMM generates overland flow maps.

Ground water heads, or the elevation of the water table, as simulated by the subregional models can be displayed for large areas as well. Ground water heads are generated for each cell in the model area, then grouped together to display ground water gradients. Changes in the gradients over time is animated for the period of record for the water table and production zone where public water supplies are withdrawn.

To compare changes in ground water heads between runs, ground water head differences are generated. A cell's ground water head at a specific date in the period of record in a run is compared to the ground water head for the same location and date in another run. The ground water head differences for the cells in a model's area are animated for the water table (Layer 1) and the production zone (Layer 3 or 4, depending on the model).

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